

WHAT WE CLAIM ARE:

1. A distributed feedback semiconductor laser, comprising:

a lower quantum well structure extending along a resonator direction,  
said lower quantum well structure having a lamination of alternately stacked lower  
5 barrier layer and lower well layer having a band gap narrower than the lower barrier  
layer;

an intermediate layer disposed on said lower quantum well structure,  
said intermediate layer having a band gap broader than the lower well layer and a  
thickness thicker than the lower barrier layer; and

10 an upper quantum well structure periodically disposed on said  
intermediate layer along the resonator direction, said upper quantum well structure  
having a lamination of alternately stacked upper well layer and upper barrier layer  
having a band gap broader than the upper well layer.

15 2. The distributed feedback semiconductor laser according to claim 1, further  
comprising a diffraction-grating-burying layer disposed on said intermediate layer  
along the resonator direction and covering said upper quantum well structure, said  
diffraction-grating-burying layer having a band gap broader than the lower and upper  
well layers.

20 3. The distributed feedback semiconductor laser according to claim 2, wherein said  
intermediate layer has a surface step of a same repetition period and a same phase in  
repetition cycle as said upper quantum well structure.

25 4. The distributed feedback semiconductor laser according to claim 2, wherein said  
diffraction-grating-burying layer has a refractive index not higher than a refractive

index of said intermediate layer.

5. The distributed feedback semiconductor laser according to claim 4, wherein said diffraction-grating-burying layer has a refractive index lower than a refractive index of said intermediate layer.

6. The distributed feedback semiconductor laser according to claim 4, wherein the refractive index of said intermediate layer is lower than a refractive index of the lower barrier layer.

7. The distributed feedback semiconductor laser according to claim 4, wherein the refractive index of said intermediate layer is substantially same as a refractive index of the lower barrier layer.

8. The distributed feedback semiconductor laser according to claim 4, wherein the refractive index of said intermediate layer has an intermediate value between a refractive index of the upper and lower barrier layers and a refractive index of said diffraction-grating-burying layer.

9. The distributed feedback semiconductor laser according to claim 1, wherein said intermediate layer has a thickness of not larger than 300 nm under said upper quantum well structure.

10. The distributed feedback semiconductor laser according to claim 4, wherein said intermediate layer and said diffraction-grating-burying layer have a substantially same refractive index.

11. The distributed feedback semiconductor laser according to claim 1, further comprising:

an InP substrate for supporting said lower quantum well structure,

wherein the lower and upper well layers are made of InGaAsP having a composition for a 1.5  $\mu\text{m}$  band and the lower and upper barrier layers are made of InGaAsP having a composition for a shorter wavelength than 1.5  $\mu\text{m}$ .

12. The distributed feedback semiconductor laser according to claim 11, wherein the lower and upper barrier layers are made of InGaAsP having a composition for a 1.2  $\mu\text{m}$  band to 1.4  $\mu\text{m}$  band.

13. The distributed feedback semiconductor laser according to claim 11, wherein said intermediate layer is made of InGaAsP having a composition for a 1.2  $\mu\text{m}$  band to a 1.4  $\mu\text{m}$  band.

14. The distributed feedback semiconductor laser according to claim 11, wherein said diffraction-grating-burying layer is made of InGaAsP or InP.

15. The distributed feedback semiconductor laser according to claim 8, wherein said diffraction-grating-burying layer is made of InGaAsP and the distributed feedback semiconductor laser further comprises an InP clad layer formed on said diffraction-grating-burying layer.

16. The distributed feedback semiconductor laser according to claim 11, wherein said upper quantum well structure, said intermediate layer and said lower quantum well

structure are shaped in a stripe form and the distributed feedback semiconductor laser is a mesa or ridge type laser.

17. A method of manufacturing a distributed feedback semiconductor laser,

5 comprising the steps of:

(a) growing on a semiconductor substrate a lamination of alternately stacked lower barrier layer and lower well layer having a band gap narrower than the lower barrier layer, to form a lower quantum well structure;

10 (b) growing an intermediate layer on an uppermost lower well layer, the intermediate layer having a band gap broader than the lower well layer and a thickness thicker than the lower barrier layer;

15 (c) growing on the intermediate layer a lamination of alternately stacked upper well layer and upper barrier layer having a band gap broader than the upper well layer and a thickness thinner than the intermediate layer, to form an upper quantum well structure;

(d) forming a mask on the upper quantum well structure, the mask having periodical pattern;

20 (e) by using the mask as an etching mask, etching the upper quantum well structure in a periodical shape by using the intermediate layer as an etching margin layer; and

(f) removing the mask.

18. The method of manufacturing a distributed feedback semiconductor laser according to claim 17, further comprising a step of:

25 (g) growing a diffraction-grating-burying layer on the intermediate layer after said step (f), the diffraction-grating-burying layer covering the etched upper

quantum well structure and having a band gap broader than the upper and lower well layers.

19. The method of manufacturing a distributed feedback semiconductor laser

5 according to claim 18, further comprising a step of:

(h) growing a clad layer on the diffraction-grating-burying layer after said step (g).

20. The method of manufacturing a distributed feedback semiconductor laser

10 according to claim 18, further comprising the steps of:

(i) forming a stripe-shaped hard mask on the diffraction-grating-burying layer, the stripe-shaped hard mask extending along a direction traversing the periodical patterns;

15 (j) etching the diffraction-grating-burying layer, the upper quantum well structure, the intermediate layer and the lower quantum well structure, using the hard mask as an etching mask, to form a mesa structure;

(k) growing a mesa-burying-layer for burying side walls of the etched mesa structure; and

(l) removing the hard mask.

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21. The method of manufacturing a distributed feedback semiconductor laser

according to claim 17, wherein the mask having the periodical patterns is formed by performing two-beam interference exposure and development of a photoresist layer.